What is claimed is:

1. A method comprising:
ejecting charged particles from a mass selection device;
receiving the charged particles at an ion trap;
illuminating the charged particles received at the ion trap to induce fluorescence; and
detecting the fluorescence.

2. The method of claim 1, further comprising ejecting the charged particles from the ion trap at selected time periods.

3. The method of claim 1 in which ejecting the charged particles comprises selectively ejecting the charged particles based on mass-to-charge ratios of the particles.

4. The method of claim 1 in which the mass selection device comprises an ion trap.

5. The method of claim 4, further comprising applying a first time-varying signal to the ion trap of the mass selection device, and sweeping a frequency of the first time-varying signal from a first frequency to a second frequency to cause particles having different mass-to-charge ratios to be ejected from the mass selection device at different frequencies of the first time-varying signal.

6. The method of claim 4 in which the frequency of the first time-varying signal is scanned according to a non-linear function of time so that the mass-to-charge ratios of the particles ejected from the ion trap comprises a linear function of time.

7. The method of claim 4, further comprising applying a second time-varying signal to the ion trap that receives the charged particles ejected from the mass selection device, and sweeping a frequency of the second time-varying signal based on the sweeping of the frequency of the first time-varying signal.

8. The method of claim 1, further comprising generating a mass spectrum by correlating an amount of fluorescence that is detected with characteristics of the mass selection device.

9. The method of claim 8 in which the characteristics of the mass selection device comprise a relationship between mass-to-charge ratios of particles ejected from the mass selection device and a time-varying control signal applied to the mass selection device.

10. The method of claim 1, further comprising applying a time-varying signal to the ion trap to generate a time-varying electromagnetic field to keep the charged particles within the ion trap.

11. The method of claim 10, further comprising turning off the time-varying signal at selected time periods to remove substantially all of the particles from the ion trap.

12. The method of claim 10, further comprising applying a direct-current voltage signal to the ion trap at selected time periods to induce an electromagnetic field that facilitates removal of the particles from the ion trap.

13. The method of claim 1 in which detecting the fluorescence comprises counting photons emitted from the particles.

14. The method of claim 1, further comprising directing a laser to a sample to ionize particles and supplying the particles to the mass selection device.

15. The method of claim 1, further comprising using electrospray ionization to generate the charged particles and supplying the charged particles to the mass selection device.

16. The method of claim 1, further comprising using photo-ionization to generate the charged particles and supplying the charged particles to the mass selection device.

17. The method of claim 1 in which illuminating the charged particles comprises directing a laser beam towards the charged particles, the laser beam having a wavelength selected to induce fluorescence from the charged particles.

18. The method of claim 1, further comprising tagging the charged particles with fluorescent dye molecules.

19. The method of claim 1, further comprising tagging the charged particles with more than one type of fluorescent dye molecules that emit fluorescence having different wavelengths.

20. The method of claim 19, further comprising illuminating the charged particles received at the second ion trap using a light beam with components having different wavelengths that are selected to induce fluorescence having different wavelengths from the different types of fluorescent dye molecules.

21. The method of claim 20, further comprising generating a mass spectrum for each group of particles tagged with a particular type of fluorescent dye molecules.

22. A method comprising:

receiving charged particles at an ion trap, the charged particle traveling at a speed greater than 1 meter per second prior to being received by the ion trap;

applying a trap driving signal to the ion trap to generate an electromagnetic field in the ion trap to cause the charged particles to be trapped within the ion trap;

illuminating the charged particles received at the ion trap to induce fluorescence; and

detecting the fluorescence emitted from the charged particles.

23. The method of claim 22, further comprising selectively ejecting the charged particles from a mass selection device based on mass-to-charge ratios of the charged particles, at least a portion of the particles ejected from the mass selection device being received by the ion trap.

24. A method comprising:

applying a first time-varying voltage signal to a first ion trap that has charged particles;

scanning a frequency of the first time-varying voltage signal from a first frequency to a second frequency to selectively eject the charged particles;

applying a second time-varying voltage signal to a second ion trap that receives the charged particles ejected from the first ion trap; and

scanning a frequency of the second time-varying voltage signal according to a predefined relationship to the frequency of the first time-varying voltage signal to tend to keep the charged particles received by the second ion trap in the second ion trap.

25. The method of claim 24 in which the frequency of the second time-varying voltage signal is scanned so as to maintain a trap parameter (q_Z) of the second ion trap substantially constant with respect to the particles received by the second ion trap.

26. The method of claim 25 in which the trap parameter q_Z is proportional to the amplitude of the second time-varying voltage signal and inversely proportional to the square of the frequency of the second time-varying voltage signal.

27. A method comprising:

receiving charged particles at an ion trap;

generate a time-varying electromagnetic field in the ion trap; and

scanning a frequency of the time-varying electromagnetic field to tend to keep the charged particles in the ion trap.

28. The method of claim 27 in which the charged particles have velocities that vary according to a predetermined function of time.

29. The method of claim 28 in which the scanning of the frequency of the time-varying electromagnetic field is based on the predetermined function of time.

30. A method comprising:

selectively ejecting ions out of a mass selection device based on mass-to-charge ratios of the ions;

using an ion trap to collect the ions ejected from the mass selection device;

detecting light emitted from the ions in the ion trap to generate a detection signal; and

correlating the detection signal with characteristics of the mass selection device to determine a mass spectrum on the ions in the ion trap.

31. The method of claim 30, further comprising directing a laser toward ions in the ion trap to induce fluorescence, and detecting light emitted from the ions comprises detecting the fluorescence emitted from the ions.

32. A method comprising:

using an ion trap to reduce speeds of charged particles selectively ejected from a mass selection device; and

detecting fluorescence induced by a laser and emitted from the charged particles.

33. The method of claim 32 in which the ions are either inherently fluorescent or are tagged with molecules that are fluorescent.

34. The method of claim 32 in which the mass selection device comprises another ion trap.

35. The method of claim 32, further comprising selectively dumping the charged particles from the ion trap.

36. The method of claim 35 in which dumping of the charged particles from the ion trap is selected so that the fluorescence that is detected between two dumps represents an amount of charged particles having mass-to-charge ratios with a particular range.

37. A method comprising:

receiving charged particles at an ion trap;

applying a time-varying voltage signal to the ion trap to create a time-varying electromagnetic field in the ion trap; and

selectively applying a direct-current voltage signal to the ion trap to cause the charged particles to be ejected from the ion trap.

38. The method of claim 37 in which the polarity of the direct-current voltage depends on the polarity of the charges of the charged particles.

39. The method of claim 38, further comprising selectively turning off the time-varying voltage signal when the direct-current voltage signal is applied to the ion trap.

40. An apparatus comprising:

a mass selection device that selectively ejects charged particles;

an ion trap to receive the charged particles ejected from the mass selection device;

a light source to generate light to illuminate the charged particles in the ion trap to induce fluorescence; and

a detector to detect the fluorescence.

41. The apparatus of claim 40 in which the mass selection device comprises another ion trap.

42. The apparatus of claim 40 in which the ion trap comprises a ring electrode, a first end-cap electrode, and a second end-cap electrode, the charged particles entering the ion trap through a hole in the first end-cap electrode and exiting the ion trap through a hole in the second end-cap electrode.

43. The apparatus of claim 40, further comprising a signal generator to generate a time-varying voltage signal, which when applied to the ion trap, generates a time-varying electromagnetic field in the ion trap to cause the particles ejected from the mass selection device to be trapped in the ion trap.

44. The apparatus of claim 40 in which the detector comprises a photomultiplier tube.

45. The apparatus of claim 40 in which the charged particles are fluorescent.

46. The apparatus of claim 40 in which the charged particles are tagged with fluorescent dye molecules.

47. The apparatus of claim 40, further comprising a laser source to generate a laser beam that is directed towards the particles in the ion trap.

48. The apparatus of claim 40, further comprising a signal generator to generate a time-varying signal that is applied to the mass selection device, the signal generator scanning a frequency of the time-varying voltage signal from a first frequency to a second frequency during a measurement cycle to cause particles to be selectively ejected from the mass selection device based on mass-to-charge ratios of the particles.

49. The apparatus of claim 48 in which the signal generator scans the frequency of the time-varying voltage signal so that the frequency changes according to a non- linear function of time designed so that the particles ejected out of the ion trap during the measurement cycle have mass-to-charge ratios that vary as a linear function of time.

50. An apparatus comprising:

an ion trap to receive charged particles selectively ejected out of a mass selection device based on mass-to-charge ratios of the particles; and

a photodetector to detect light emitted from the particles in the ion trap.

51. The apparatus of claim 50, further comprising a laser generator to generate a laser beam that is directed at the charged particles in the ion trap to induce fluorescence.

52. The apparatus of claim 50, further comprising a circuit to generate a control voltage that is applied to the ion trap to cause the ion trap to eject particles at selected times, the ejections of particles spaced apart for at least a specified time period to allow the photodetector to detect the light from the particles.

53. The apparatus of claim 50 in which the laser generator generates a laser beam having a wavelength selected to induce fluorescence from the charged particles.

54. An apparatus comprising:

an ion trap to receive charged particles traveling at a speed greater than 1 meter per second prior to being received by the ion trap;

a signal generator to generate a trap driving signal that is applied to the ion trap to generate an electromagnetic field in the ion trap to cause the charged particles to be trapped within the ion trap;

a laser generator to generate a laser beam to illuminate the charged particles received at the ion trap to induce fluorescence; and

a detector to detect the fluorescence emitted from the charged particles.

55. The apparatus of claim 54, further comprising a mass selection device to selectively eject the charged particles based on mass-to-charge ratios of the charged particles, at least a portion of the particles ejected from the mass selection device being received by the ion trap.

56. An apparatus comprising:

a first signal generator to generate a first time-varying voltage signal that is applied to a first ion trap having charged particles, the first signal generator scanning a frequency of the first time-varying voltage signal from a first frequency to a second frequency to selectively eject the charged particles from the first ion trap; and

a second signal generator to generate a second time-varying voltage signal that is applied to a second ion trap that receives the charged particles ejected from the first ion trap, the second signal generator scanning a frequency of the second time-varying voltage signal according to a predefined relationship to the frequency of the first time-varying voltage signal to tend to keep the charged particles received by the second ion trap in the second ion trap.

57. The apparatus of claim 56, further comprising a third signal generator to generate a third voltage signal that is selectively applied to the second ion trap to cause the charged particles in the second ion trap to be ejected from the second ion trap.

58. The apparatus of claim 57 in which the third voltage signal comprises a direct-current voltage signal.

59. The apparatus of claim 56 in which the second signal generator scans the frequency of the second time-varying voltage signal so as to maintain a trap parameter (q_Z) of the second ion trap substantially constant with respect to the particles received by the second ion trap.

60. The apparatus of claim 59 in which the trap parameter q_Z is proportional to the amplitude of the second time-varying voltage signal and inversely proportional to the square of the frequency of the second time-varying voltage signal.

61. An apparatus comprising:

an ion trap to receive charged particles traveling at different velocities at different time periods; and

a signal generator to generate a time-varying control signal that is applied to the ion trap to generate a time-varying electromagnetic field in the ion trap, the signal generator scanning a frequency of the time-varying control signal to tend to keep the charged particles in the ion trap.

62. The apparatus of claim 61 in which the charged particles have velocities that vary according to a predetermined function of time.

63. The apparatus of claim 62 in which the signal generator scans the frequency of the time-varying control signal based on the predetermined function of time.

64. A apparatus comprising:

a mass selection device that selectively ejects ions based on mass-to-charge ratios of the ions;

an ion trap that collects the ions ejected from the mass selection device;

a detector to detect light emitted from the ions in the ion trap to generate a detection signal; and

a data processor to correlate the detection signal with characteristics of the mass selection device to determine a mass spectrum on the ions in the ion trap.

65. The apparatus of claim 64, further comprising a laser generator to generate a laser beam that is directed towards the ions in the ion trap to induce fluorescence.

66. An apparatus comprising:

an ion trap to reduce speeds of charged particles selectively ejected from a mass selection device; and

a detector to detect fluorescence induced by a laser and emitted from the charged particles.

67. The apparatus of claim 66 in which the ions are either inherently fluorescent or are tagged with molecules that are fluorescent.

68. The apparatus of claim 66 in which the mass selection device comprises another ion trap.

69. The apparatus of claim 66, further comprising selectively dumping the charged particles from the ion trap.

70. The apparatus of claim 69 in which dumping of the charged particles from the ion trap is selected so that the fluorescence that is detected between two dumps represents an amount of charged particles having mass-to-charge ratios with a particular range.

71. An apparatus comprising:

an ion trap to receive charged particles;

a first signal generator to generate a time-varying voltage signal that is applied to the ion trap to create a time-varying electromagnetic field in the ion trap; and

a second signal generator to generate a dumping voltage signal that is selectively applied to the ion trap, the dumping voltage signal having a polarity based on a polarity of the charges of the charged particles, the dumping voltage signal causing the charged particles to be ejected from the ion trap.

72. The apparatus of claim 71 in which the dumping voltage signal comprises a direct-current voltage signal.

73. The apparatus of claim 71 in which the first signal generator selectively turns off the time-varying voltage signal when the dumping voltage signal is applied to the ion trap.